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THE JOINT STRIKE FIGHTER

A Development Study

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by

Maj Derek W. Avance
Maj Robert E. Clay
Maj David S. Grantham
Maj David Kelly
Maj John Rupp

Maj Christopher S. Ceplecha
Maj Terry M. Featherston
Maj Patrick A. Kelleher
LCDR Garry L. Pendleton
Maj Christopher E. Yelder

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AIR COMMAND AND STAFF COLLEGE
MAXWELL AFB, AL 36112

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Preface

The Joint Strike Fighter (JSF) program is responsible for producing the next generation of strike aircraft for the Air Force, Navy, and Marine Corps. The research team concluded that the individual services are fixated on individual service needs at the expense of warfighting capability and mission requirements for the 21st century battlefield. This study examines the JSF program, then proposes that the mission of future strike warfare can best be accomplished by the short takeoff, vertical landing (STOVL) strike fighter.

This development study initially intended to provide the United States Marine Corps (USMC) with recommendations for a more capable strike platform. However, the research team subsequently decided that parochial interests and USMC desires should not dominate the research effort. This modified focus produced a more holistic approach that applies to all three services. The critical development criteria promoted by the JSF program office and the individual services are thoroughly examined. The research team offers alternative views in several areas with the intent of influencing the final design. The value of this study lies in its potential to make such a contribution.

The research team acknowledges the efforts of numerous military officers, civilian engineers, and defense industry reporters who shared their JSF insights. Their knowledge of the program provided a research foundation. The greatest acknowledgment, however, is reserved for the team's faculty research advisor, Colonel Tom Moore and his assistant,

Lieutenant Colonel Ed Gregory. Their guidance and encouragement over the course of the study convinced team members that audacity, tempered with honesty, produces an unbiased and viable product.

Abstract

The Joint Strike Fighter (JSF) program is responsible for the development of the next generation of strike-fighter aircraft for the Air Force, Navy, and Marine Corps. The program is approaching critical stages in the development process. This study proposes that the JSF program is veering off course. The individual desires of the Air Force, Navy, and Marine Corps are superseding the requirements for a preeminent strike fighter.

JSF program objectives are clearly defined. The JSF must be joint, operationally sound, and affordable. This development study proposes that the JSF must also be expeditionary and capable of performing in the littoral arena. These requirements can be met by the development and deployment of a single aircraft. The short takeoff, vertical landing (STOVL) variant of the JSF should be the choice of the US. It will successfully accomplish the mission of strike warfare for all three services. A flexible development study process consisting of independent research, interviews, and group discussion led to this thesis.

This study initially provides background information on the JSF program and examines the emerging environment of conflict. It then provides tactical recommendations for the design of the JSF and expounds on the benefits gained by the employment of a single strike fighter. Finally, an architecture for the planning, transition, and implementation of the JSF is offered to ensure it meets and exceeds the demands of strike warfare in the 21st century.

Chapter 1

Introduction and Problem Definition

The [Defense Science Board] Task Force found that the numbers of aircraft needed to sustain force levels in all three services require that there be revolutionary improvements in aircraft affordability.

—Defense Science Board Task Force report on JAST [JSF]
September 1994

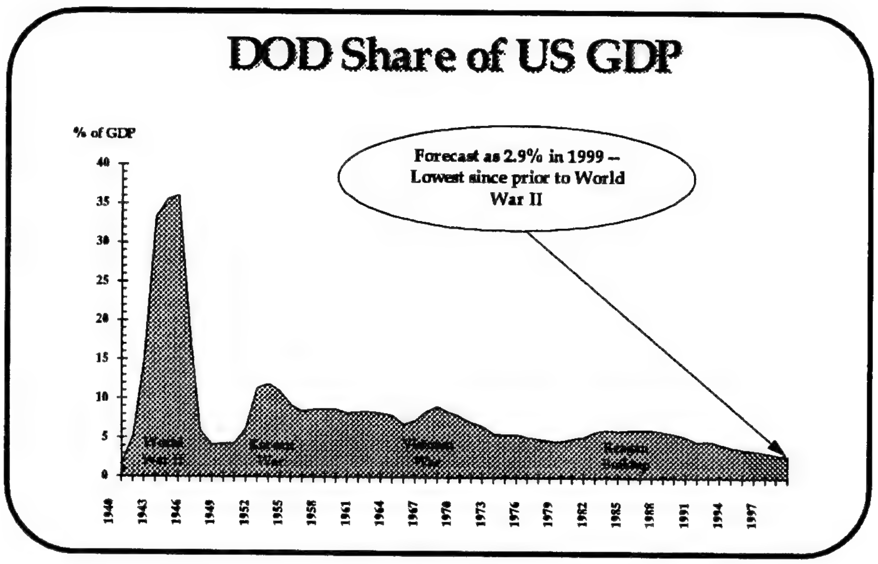
Introduction and Problem Definition

The United States military is undergoing a critical transformation. A new world order led by the United States of America has not materialized in the shape or manner once predicted by former President George Bush. Instead, the United States and its military are engaged in a world characterized by ethnic strife, transnational violence, and an acute sense of hatred that knows no bounds or borders. The US is enmeshed in a *global state of disorder.*

The military components of the US are attempting to predict the regional conflicts of tomorrow. They are planning to meet the national security threats of the future. As the world's only superpower, the US is in the unique position to shape events around the globe to provide a more peaceful and compatible national security environment.

Concurrently, the defense establishment is experiencing its most drastic reshaping since World War II. Fiscal realities and the need for efficiency leave the services with

few alternatives. The people of the United States expect the military to develop and procure systems that are necessary, affordable, and applicable to the needs of all services. The development of weapon systems in an evolving strategic environment has become complicated by the reality of shrinking defense budgets. Department of Defense (DOD) outlays as a percentage of gross domestic product (GDP) have declined since 1992. This trend is expected to continue (fig. 1).



Source: Lt Col Jon Krenkel, "Joint Requirements Oversight Council and the Joint Warfighting Capabilities Assessment Process," lecture, Air Command and Staff College, Maxwell AFB, Ala., 12 February 1996.

Figure 1. DOD Share of US GDP

The DOD is responding to this austere environment in a number of ways. The most significant change is the realization that aggressive pursuit of joint cooperation in defense-related matters yields operational and fiscal dividends. In no area is this more prevalent than weapon system development and procurement. The Joint Strike Fighter (JSF) program, formerly the Joint Advanced Strike Technology (JAST) program, is a product of this new initiative. Its goal is to produce the next generation of strike-fighter

aircraft for the Air Force, Navy, and Marine Corps capable of defeating the 21st century threat. The JSF is the strike aircraft of the future and the subject of this development study.

The JSF concept originated in 1993 as a result of former Secretary of Defense Les Aspin's Bottom-Up Review. The JSF program consolidated the efforts of all three services for the production of the next generation strike fighter. The mission of the JSF program is to "facilitate development of fully validated operational requirements, proven operational concepts, and transition mature technologies to support successful development and production of affordable next-generation strike weapon systems for the Navy, Marine Corps, Air Force, and our allies."[1] In layman's terms, the JSF program is charged with projecting requirements, developing concepts, and producing the strike fighter of the future. This must be accomplished with affordability as a cornerstone of success. "Key program objectives are to significantly reduce the cost of performing joint strike warfare, demonstrate the critical operational concepts, and identify and demonstrate innovative solutions and approaches to affordable joint strike warfare."[2] The program objectives are clear. The JSF should be joint, operationally sound, and affordable.

The JSF program is approaching critical points in the weapon system development process. As the program matures, it appears the three air services involved are not cooperating, but diverging. Parochial interests threaten to drive the program off course. This is not unexpected. Admiral William Owens, former Vice Chairman of the Joints Chiefs of Staff, has expressed the view that "history reveals a tendency for the services to diverge rather than coalesce during periods of relative fiscal austerity. That is, each service tends to put planning priority on assuring and protecting core competencies at the

expense of those capabilities that support and facilitate operations of the other services."[3] The current problems in the JSF program stem from the desire of each service to tailor this aircraft to perform its perceived service missions.

The Air Force, Navy, and Marine Corps need the JSF to fill voids in their aviation tasking. The Air Force needs the JSF to fill the battlefield air interdiction and close air support functions of its aging F-16s and A-10s. The Navy needs the JSF to provide a survivable advanced strike capability that complements the F/A-18 E/F and replaces the A-6. The Marines need this aircraft to be expeditionary and capable of replacing its aging F/A-18s and AV-8s in the close air support role.

Each service has defined its desired JSF capabilities. However, they have not thoroughly considered how such an aircraft can fill the needs of the combatant commanders who will fight and win our nation's conflicts. The parochial desires of the Air Force, Navy, and Marine Corps should be secondary to what *missions* the strike-fighter aircraft of the next century is required to perform.

The strike missions of each air service do not vary widely. Indeed, many of the missions are identical except for each service's unique doctrinal terminology. The strike requirements for all three services fall into a narrow band so definable that the mission of strike warfare should be performed by one aircraft, not three (fig. 2).

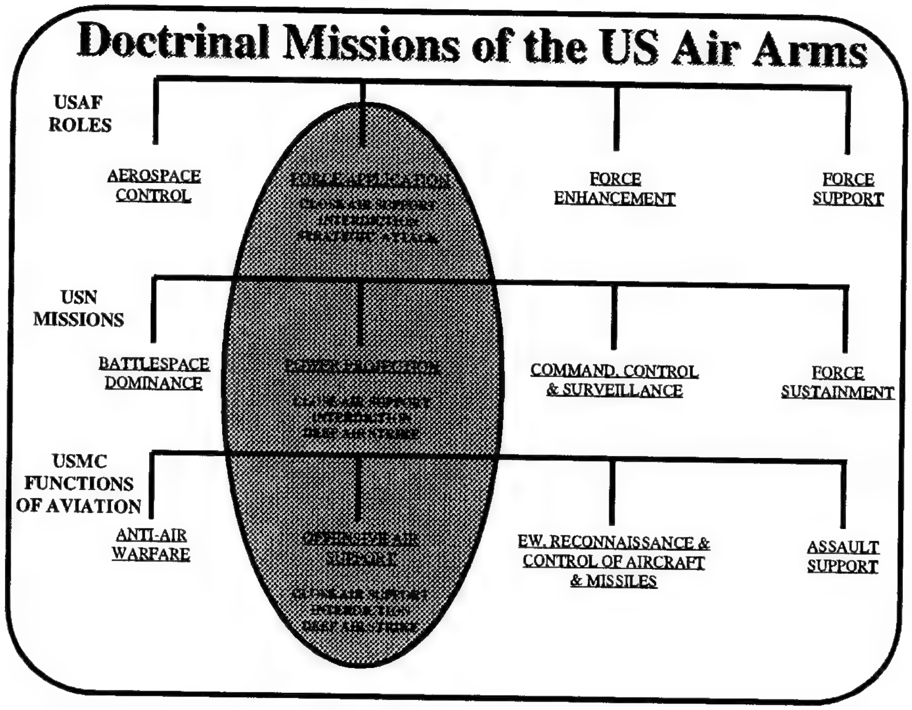


Figure 2. Doctrinal Missions of US Air Arms

Before progressing any further, it is necessary to define the mission of strike warfare for the JSF. As depicted in figure 2, all three services have potential strike missions of close air support, interdiction, and deep strike/strategic attack. The composition and distance to potential targets and the proximity of US troops normally define the limits of these three tasks. This development study proposes that JSF utilization will predominantly fall within the realm of close air support and interdiction. Expensive stealth aircraft and cruise missiles will continue to perform the deep strike mission. The JSF program should concentrate its efforts on producing an aircraft unmatched in the performance of close air support and interdiction (fig. 3).

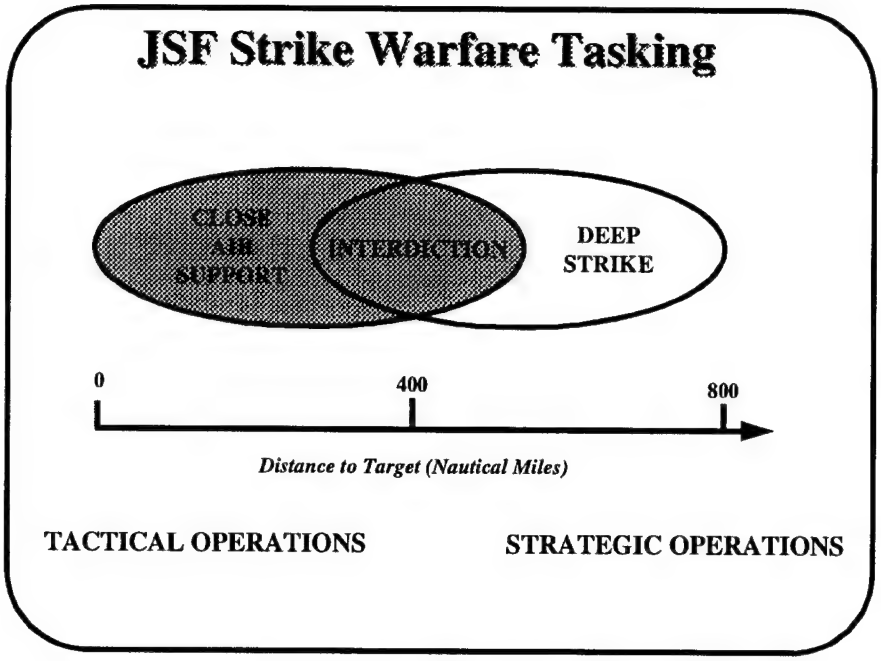


Figure 3. JSF Strike Warfare Tasking

The thesis of this development study is clear: The Joint Strike Fighter needs to be designed to perform *the mission of strike warfare* in the 21st century. The parochial desires of each competing service must be subjected to intense scrutiny, especially in light of the current fiscal environment. The Joint Strike Fighter should be joint, operationally sound, and affordable. It should be one aircraft, not three derivatives. The Joint Strike Fighter chosen to fight in the 21st century should be *the short takeoff, vertical landing (STOVL) variant.* By examining the emerging global environment and how the United States plans to respond to conflict in the future, it will become clear that the STOVL JSF is the choice for the US.

Development Study Assumptions

The scope of this study has been limited to aircraft systems and the desired tactical capabilities of the aircraft. Aircraft performance in propulsion, aerodynamics, and other airframe-related areas is not covered because initial research revealed that their development is well underway. Recommendations in these areas would have little chance of affecting the eventual design of the aircraft. Instead, the study has taken *a tacticians approach.*

This study, conducted by the research team with over 20,000 hours of operational and combat flight experience, provides recommendations to make the systems and weapons more versatile and lethal. These recommendations should provide the strike-fighter pilot of the 21st century with an aircraft that can successfully accomplish *the mission of strike warfare.*

This development study proposes the manufacture of a single airframe JSF, based on the following assumptions:

1. The JSF period of employment will be the 2010–2035 time frame.
2. Air Force, Navy, and Marine Corps roles and missions will not significant change prior to the introduction of this aircraft.
3. US air forces will operate throughout the full spectrum of conflict.
4. US air forces will be employed as part of a joint or combined task force, heavily dependent on interoperability.
5. The JSF will perform in an expeditionary environment.
6. The JSF will perform in the littoral regions.
7. Advanced technologies employed on the JSF will permit STOVL flight which is efficient, reliable, and affordable.

At the heart of these assumptions is the commonly held belief that the conduct of warfare in the 21st century will be distinctly different from that experienced throughout most of the 20th century. The application of the military instrument of power will no

longer be the domain of one particular service. "In the new paradigm it is difficult to envision any point on the conflict spectrum where a single service would be committed alone."[4] The STOVL JSF will be a crucial addition in this emerging era of joint warfare.

Methodology and Review of Related Literature

The research team used a flexible methodology to research and project the desired capabilities of the JSF (fig. 4). The thesis and breadth of this development study were discussed vigorously among team members. The initial stage of research was spent canvassing military periodicals and aerospace technology publications to establish a base of knowledge that allowed team members to conduct follow-up interviews.

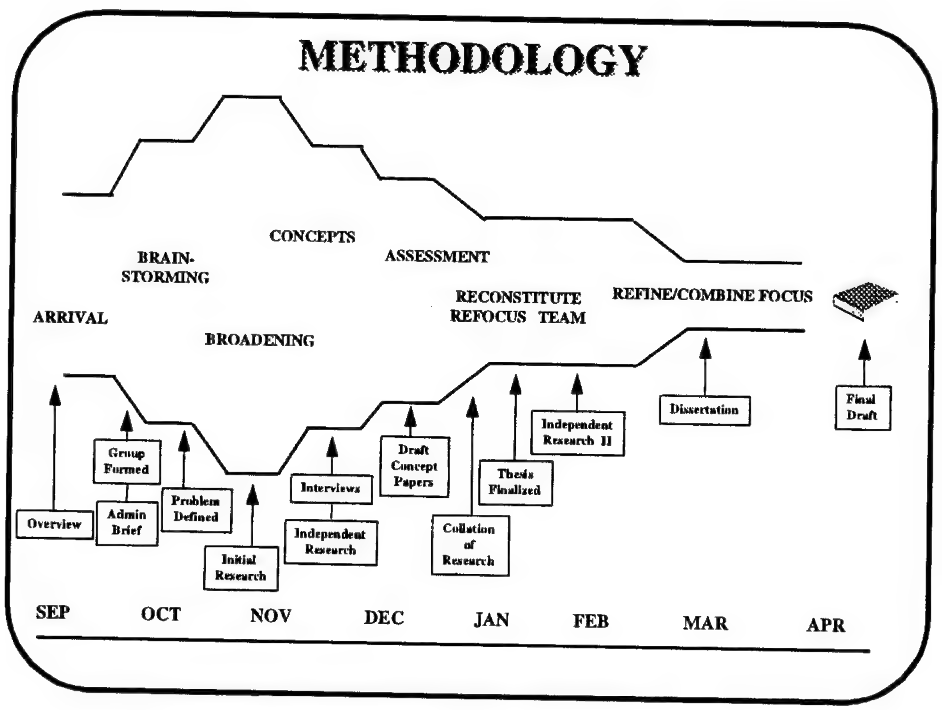


Figure 4. Methodology

During the next stage of research, team members were selected to interview personnel directly involved in the JSF. Military representatives, industry experts, tech-

nologists, and authors of JSF/JAST literature were accessible via telephone. Their viewpoints were used as a foundation for later development and research. The research effort was then divided into conceptual areas of responsibility and independent research on subjects as wide ranging as the global environment and aircraft technologies was conducted. Each team member then presented his findings as an initial research draft document which covered his conceptual areas of responsibility in detail. The collation of all writings was then shared among the team members. A series of dynamic group discussions then allowed members to share their operational points of view.

The final stage of research led team members to conclude that the production of a single model JSF was the most viable and efficient option. With a thesis finalized and a structure of the development study agreed upon, team members completed their research responsibilities and presented their findings. Since that time, the study has been completed and is presented here in its final form.

A review of related literature revealed that many of the specifics regarding the JSF program and its emerging aircraft are classified. However, among the worldwide web of information, military periodicals, and aerospace technology magazines, there exists enough data to form a basis of information. As a result, this study draws upon material obtained through individual research and extensive group discussion based on the individual and collective flight experience of the team members.

Overview

This development study proposes that the design of the JSF should hinge upon the *mission requirements* of the next century. Chapter 2 will validate the planning

assumptions and expound on the emerging environment of conflict. Chapter 3 will delineate the desired capabilities of the JSF. Chapter 4 will discuss the operational, training, and maintenance benefits derived through the production of a single airframe. Chapter 5 will provide a framework for the planning, transition, and implementation of the Joint Strike Fighter and summarize this study's conclusions.

Notes

[1] RADM Craig E. Steidle, "Joint Advanced Strike Technology 1994 Annual Report and Master Plan," *JAST Internet Home Page*, October 1995, Slide 2.

[2] Ibid.

[3] ADM William A. Owens, "JROC: Harnessing the Revolution in Military Affairs," *Joint Force Quarterly*, no. 5 (Summer 1994): 56.

[4] Lt Col Frederick R. Strain, "The New Joint Warfare," *Joint Force Quarterly*, no. 2 (Autumn 1993): 18.

Chapter 2

The Environment of Conflict

Unless soldiers and statesmen, diplomats and arms–control negotiators, peace activists and politicians understand what lies ahead, we may find ourselves fighting—or preventing—the wars of the past rather than those of tomorrow.

—Alvin and Heidi Toffler
War and Anti-War

Introduction

The ability to accurately project the desired capabilities of a future aircraft depends upon the environment in which the nation expects to employ it. This chapter analyzes the current global situation, predicts the environment of conflict in the year 2010, and validates the previous assumptions regarding the future of warfighting. Specifically, it examines the requirements for the JSF to be expeditionary, configured for operations in the world's littorals, and capable of sustained operations in a joint environment.

The Emerging Global Environment

To accurately assess the global environment of the early 21st century, it is necessary to examine history, evaluate the current state of world affairs, and project the future. The US and its NATO allies have spent the years since World War II chiefly concerned with the prospect of fighting a major campaign against the Warsaw Pact nations, specifically

the former Soviet Union (FSU). With the end of the cold war and the democratization of Eastern Europe and the FSU, the US and its allies are no longer predominantly concerned with the threat of Russian aggression.

Instead, the US has concentrated recent defense efforts on the ability to simultaneously fight, and decisively win, two major regional conflicts (MRCs). The *National Military Strategy of the United States of America* (NMS) for 1995 identifies this core requirement as the basis for US military capabilities. However, the NMS points out that "challenges to our global interests did not disappear with the end of the Cold War. Today we face a world in which threats are widespread and uncertain, and where conflict is probable, but too often unpredictable."[1]

The NMS portends the paradox the military services will face in 2010. In one case, core capabilities will be based on fighting and winning dual MRCs. At the same time, the nation's forces must be prepared to confront other threats. The numerous components of military strategy listed in the NMS detail those missions which the armed forces may be required to perform. This strategy clearly states that military employment in the future will be an all-encompassing task and military operations will span the entire spectrum of conflict (fig. 5).

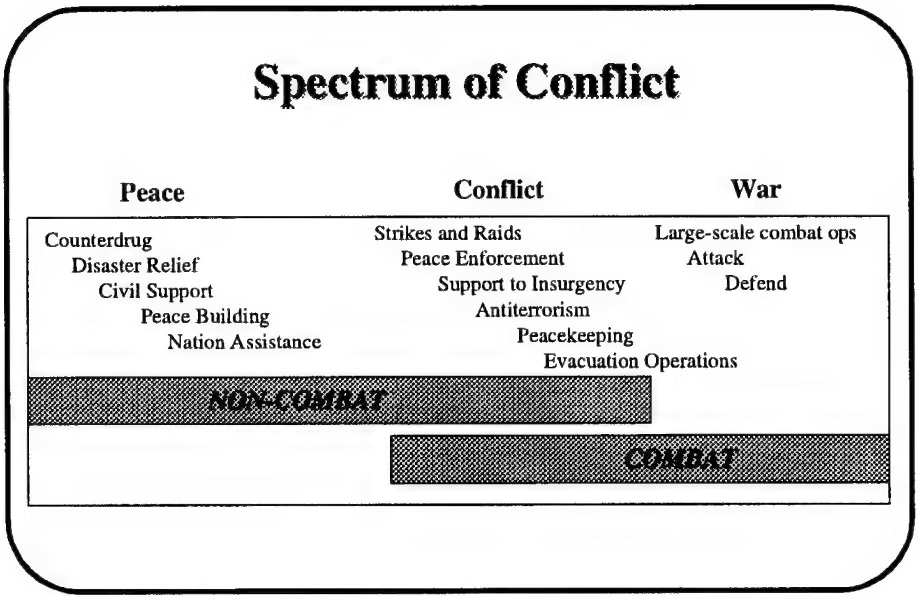


Figure 5. US Spectrum of Conflict

The NMS states that "many ethnic, religious, territorial, and economic tensions, held in check by the pressures of the bipolar global competition, erupted when the constraints posed by the Cold War were removed."[2] In many cases, the US military in concert with other agencies, will be the only force capable of keeping these eruptions from flowing out of control.

How does this affect the military and specifically JSF development? By studying the past and forecasting the future, one concludes that the JSF will be expected to respond to a wide variety of contingencies. This range of missions will require the aircraft to possess a multi-role capability. It is apparent from figure 5 that an aircraft that possesses a superior strike capability will be essential.

The NMS also identifies "overseas presence and power projection" as two complementary strategic concepts that will allow US military forces to accomplish their

assigned tasks. Not only will these two requirements exist in the future, but they may attain an unprecedented level of importance due to the frequency of US military intervention overseas. "In fact, in the five years since the fall of the Berlin Wall we have deployed our forces to assist in security or humanitarian crises about 40 times—a far greater pace than in the preceding 20 years."[3] A strike aircraft capable of deployment to potential areas of conflict will provide overseas presence and power projection.

Expeditionary Warfare

Examination of the global environment in 2010 would be incomplete if analysis overlooked the future limitations that US forces will experience. One of the most compelling limitations facing operational forces is the reduction of overseas bases and the lack of host nation support for the American military.

As a consequence of the military drawdown, overseas bases in areas as dispersed as the Mediterranean, Western Europe, South Korea, and the Philippines are no longer manned. Additionally, nations that once welcomed US forces no longer feel obligated to host the American military in a period considered less threatening than the Cold War. David S. Yost, a professor at the Naval Postgraduate School and a former fellow at the Woodrow Wilson International Center for Scholars, states that "overseas bases may not be as readily available as they were during the Cold War. Political and social trends abroad may make it more costly and difficult for the United States to maintain bases, facilities, and burden-sharing and host-nation support arrangements in specific countries and regions. In a number of nations there seems to be a growing sentiment that foreign bases amount to a derogation of sovereignty, and sometimes anti-Western or anti-

American feelings are concentrated against such installations. There is no longer a convincing Soviet threat to persuade host governments to put up with a politically sensitive US military presence."[4] It is naive to assume that US forces will always have the basing facilities required within reasonable range of future conflicts. The answer to this problem lies in the merits of *expeditionary warfare*.

The services are being proactive and are planting the seeds of expeditionary warfare. The US Navy and Marine Corps have recognized the benefits of an expeditionary approach to conflict. In *Forward . . . From the Sea*, the Navy–Marine Corps white paper of 1994, these services explained that "'expeditionary' implies a mind set, a culture, and a commitment to forces that are designed to be deployed forward and to respond swiftly."[5]

The Air Force, an organization normally accustomed to operations from sites with well-developed infrastructures, has also noted the apparent change in the strategic environment. General Merrill A. McPeak, former Chief of Staff of the US Air Force, commented on this subject in a 1990 speech. He stated, "It seems to me that we're moving from a period of garrison air force and garrison mentality to an expeditionary air force with an expeditionary mentality."[6] General McPeak recognized "the requirement to have an expeditionary air force that moves quickly from a CONUS location to a forward position and is ready to fight immediately when it gets there."[7] The basing restrictions for US forces, coupled with the validation by Air Force, Navy, and Marine Corps leaders, lends credence to the assumption that warfighting of the future and crisis response around the globe will entail the employment of expeditionary air forces. The JSF designers should embrace this expeditionary vision.

The Littoral Arena

The US is no longer faced with a credible adversary on the oceans of the world. The decline of the former Soviet naval threat allows the US military to concentrate its efforts in other areas. The coastal or *littoral* areas of the world will become the focus of these efforts. The Department of the Navy (DON) realized this point and has refocused its efforts to more effectively employ the Navy-Marine team in the littorals of the world. Both services state in a recent white paper that "our ability to command the seas allows us to resize our forces to concentrate more on the capabilities required in the complex operating environment of the 'littoral' or coastlines of the earth."[8] The air arms of all the services should follow their lead in planning for operations in these regions.

The world's littorals are those areas near or adjacent to the coast which are most likely to require a military response. In the 1992 Navy and Marine Corps white paper *...From the Sea,* a chart of the littoral region claims this area to be "within 650 miles of [the] coastal region, the striking range of Naval Forces."[9] A 1995 DON posture statement provides a conflicting perspective. It states that "in the future, as we look at crisis areas and potential conflicts, we judge that the littorals will be where they will occur. This is because virtually all of the world's population and major cities lie within 200 miles of the coast."[10] These two reports suggest that the littoral region lies between 200 and 650 miles from coastal regions. The development of the JSF is difficult without a consensus on the depth of the littoral regions. A more precise definition is required.

The four significant military contingencies that occurred during 1994–1995 offer a definition based on real-world events. Conflicts in the regions of the northwest Pacific, the Persian Gulf, the Adriatic Sea, and the Caribbean Sea were all within 400 miles of the

coastline. These contingencies offer a reasonable representation of future conflict. For the purposes of this development study, a littoral area ranging from naval units off the coast inland to 400 miles will be used as the definition of littoral (fig. 6).

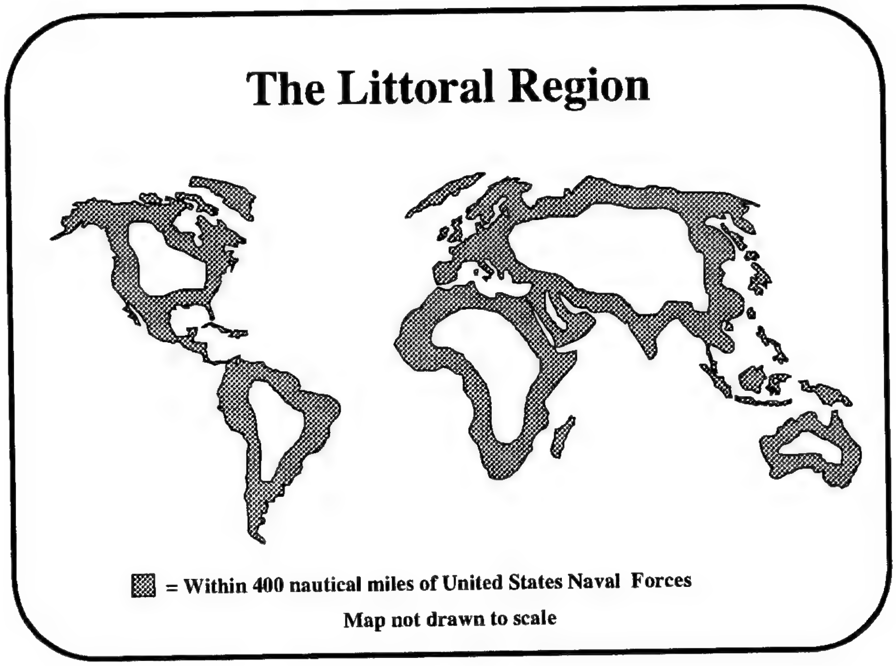


Figure 6. The Littoral Region

Joint Warfare

"The first basic element of the new warfare is the axiom that the whole is greater than the sum of its parts."[11] In an era of reduced budgets, shortages of military personnel, and an increased commitment of troops to contingencies around the globe, the new warfare of the 21st century must be joint. The military services have taken steps in this direction, firmly laying the foundation for joint warfighting. "Goldwater-Nichols legislation codified jointness and recent historical trends have reinforced this concept.

Today, few dispute the efficacy of joint warfighting, which Desert Storm clearly validated."[12]

Requests for US military involvement are steadily increasing, while the defense budget decreases. Consequently, the demands placed on joint warfighting entities will increase. "We must manage the largest decline in military resources since World War II as we maintain the flexibility to meet the demands of vigorous engagement."[13] Flexibility, in this context, means employing the right force to complete the task at hand. "No single military service embodies all of the capabilities needed to respond to every situation and threat."[14] Only those assets which are capable of complementing the capabilities currently in existence and acting as significant force multipliers should be acquired in the future. The JSF can be one of those assets.

If the services acknowledge the environment of the 21st century, they will recognize the similarity of their requirements for strike warfare. The USAF and USMC have stated that their desired performance characteristics can be met by one aircraft, provided the previous assumption regarding STOVL flight comes to fruition. The Navy, however, is soliciting an aircraft with two conflicting roles. It wants a complementary asset for its evolving F/A-18E/F and a deep strike replacement for the retiring A-6. This cannot be done with one aircraft.

The JSF should have a complementary capability for the F/A-18E/F. It should have the ability to fill the traditional light attack, multi-role mission of the carrier task force. It should also be able to augment the F/A-18E/F in the air-to-air role with its inherent air combat capabilities. It cannot simultaneously be designed to replace the A-6 with a deep strike capability. If the US Navy wants to pursue the need for a deep strike asset with

stealth capability, they could purchase a naval variant of the F-117. That aircraft would effectively complement the Tomahawk Land Attack Missile (TLAM). The USN should not be allowed to drive the JSF program off course due to its desire for a deep strike capability. If the Navy expects to fight in the littorals, it should purchase weapon systems that perform in the littorals. The JSF should not be built as a deep strike asset; it should remain a littoral performer.

Summary

The environment detailed in this chapter highlights the importance of expeditionary, littoral, and joint warfare. To master this environment, the JSF needs to takeoff in a short distance (450 feet), fly to a target using a high-low-high profile that meets the proposed 400 mile radius of action, and recover vertically in an expeditionary environment. Of the three current derivatives, only the STOVL JSF succeeds in these areas.

The STOVL JSF exceeds the program objectives and the requirements delineated in this development study. It can set the standard for expeditionary warfare. With an inherent ability to takeoff in short distances and recover vertically, the basing options are innumerable and the flexibility offered to the combatant commanders is unmatched. The STOVL JSF is capable of being *deployed forward* and *responding swiftly.*

The STOVL JSF will also generate substantial benefits in the littoral arena. Operating from the decks of naval expeditionary forces, expeditionary airfields, and major airports along the coasts, the STOVL JSF will perform unencumbered in this environment of future conflict. Mastery of the littoral will no longer be presumed. It will be achieved.

Finally, the STOVL JSF (hereafter referred to as the JSF) could introduce a joint era noted for its integration of all three air arms. This depends heavily on the Navy amending its current desires. With a more definitive concept of the littoral accepted by all three services, the JSF could be the first aircraft developed in a truly joint and cooperative venture.

Notes

[1] Gen John M. Shalikashvili, *National Military Strategy of the United States of America* (Washington, D.C.: Government Printing Office, 1995), i.

[2] Ibid.

[3] Ibid., 2.

[4] David S. Yost, "The Future of U.S. Overseas Presence," *Joint Force Quarterly*, no. 8 (Summer 1995): 75.

[5] Honorable John H. Dalton, ADM J.M. Boorda and Gen Carl E. Mundy, *Forward . . . From the Sea* (Washington, D.C.: Government Printing Office, 1994), 8.

[6] Gen Merrill S. McPeak, *Selected Works 1990–1994* (Maxwell Air Force Base, Ala.: Air University Press, August 1995), 12.

[7] Ibid.

[8] . . . *From the Sea* (Washington, D.C.: Government Printing Office, 1992), 3.

[9] Ibid., 6.

[10] Honorable John H. Dalton, ADM J.M. Boorda and Gen Carl E. Mundy, *The Navy–Marine Corps Team* (Washington, D.C.: Government Printing Office, 1995), 9.

[11] Lt Col Frederick R. Strain, "The New Joint Warfare," *Joint Force Quarterly*, no. 2 (Autumn 1993): 23.

[12] Honorable Sheila E. Widnall and Gen Ronald R. Fogleman, *Global Presence 1995* (Washington, D.C.: Government Printing Office, 1995), 15.

[13] ADM William A. Owens, "JROC: Harnessing the Revolution in Military Affairs," *Joint Force Quarterly*, no. 5 (Summer 1994): 56.

[14] Honorable John H. Dalton, ADM J.M. Boorda and Gen Carl E. Mundy, *Forward... From the Sea* (Washington, D.C.: Government Printing Office, 1994), 7.

Chapter 3

Joint Strike Fighter Mission Requirements

Since militaries are stuck with force structures they choose for long periods, it is more crucial than ever to think now in peacetime, about the impact of possible revolutionary changes in the nature of war and about what will matter in winning wars in twenty or thirty years.

—CDR James R. Fitzsimonds and CDR Jan M. Van Tol
Joint Force Quarterly

Introduction

The strength of air power is its innate flexibility. This flexibility allows the commander to shape the battlefield in favor of his forces. The success of US airpower in recent conflicts has ensured its role in the next millennium and has reinforced the adage that "*airpower* is the *key* to flexibility."[1] The JSF must be designed for the mission requirements of the future battlefield, not simply as a replacement for contemporary aircraft. It must possess several complementary capabilities to be successful. The JSF must be expeditionary in nature, survivable against future surface-to-air weapons, and able to accomplish strike warfare independently. Ultimately, the JSF must be self sufficient in detecting, identifying, tracking, killing, and assessing damage to enemy targets.

The Future Surface-to-Air Threat

This development study postulates that infrared (IR) weapons will be the threat of greatest concern to the JSF. Current surface-to-air systems operate in the infrared (IR) or radio frequency (RF) portions of the electromagnetic spectrum. Both types of weapons are lethal but IR surface-to-air missiles (SAMs) combined with anti-aircraft artillery (AAA) accounted for 85% of US Air Force losses during the Vietnam war and 71% of coalition fixed-wing attrition during Desert Storm.[2] According to Alvin Toffler, this trend is expected to continue. He believes that future warfare will likely consist of localized conflicts between tribal factions, ethnic groups, or small nations, employing shoulder-launched IR SAMs.[3] Consequently, future IR weapons should be the primary threat consideration in the JSF development process. RF threats need to be countered, but should not drive survivability efforts in the JSF program.

IR systems have two distinct advantages over RF systems. First, these systems are simple. They are relatively inexpensive, man portable, and easily installed on armored vehicles. IR SAMs require minimal maintenance and virtually no logistical tail. They are true fire-and-forget weapons. Second, there is no missile warning for the intended victim. IR warning systems for current fighter and attack aircraft have not materialized. Although some rotary-wing aircraft are presently equipped with IR warning systems, no such system is anticipated for tactical jets in the near future.

Adding to the air services' concern is the tremendous proliferation of highly sophisticated IR systems.[4] The seekers of these newer SAMs possess a high degree of built-in infrared counter-countermeasures with sophisticated target tracking logic. The target tracker in these seekers builds a digital picture of the target in its memory, then

tracks that image if countermeasures are deployed. These missiles no longer simply track the hottest spot in their field of view.[5] Such systems are extremely difficult to defeat with current aircraft defense systems. These sophisticated IR seekers must be countered to ensure the survivability of the JSF over the next 30–40 years.

In contrast, RF systems are notably complex and expensive to operate. They are normally employed in units with developed command and logistics structures. RF SAM sites are often stationary and vulnerable to enemy anti-radiation missile attack. The relative high cost, complexity, and extensive support requirements for RF SAMs make them affordable only for richer nation-states, who will deploy them as part of an integrated air defense system. These limiting factors, coupled with the demonstrated effectiveness of IR SAMs in Afghanistan and Desert Storm, suggest that IR SAMs will be the predominant threat to the JSF.

According to the *Joint Advanced Strike Technology Program*, RF survivability continues to be a significant driving force behind the development of the JSF.[6] Contrary to this vision, RF survivability should not unduly drive the JSF design at the expense of other important criteria. IR survivability and external weapons carriage are more demanding and appropriate requirements. As postulated, the JSF will be employed in areas mostly void of sophisticated RF SAMs. This does not suggest that there will never be an RF threat or that the JSF should be designed without significant RF countermeasures. However, the future IR threat is expected to be more dominant because of its mobility, simplicity, invisibility, and availability. This dictates that signature reduction efforts for the JSF should concentrate on the IR spectrum, with corresponding efforts on developing effective missile warning and countermeasure systems.

Signature Reduction

The JSF will operate in low, medium, and high-threat scenarios. To survive this spectrum of conflict, the JSF must incorporate an integrated self-defense system which includes adequate threat warning and effective countermeasures. This system will increase the aviators' situational awareness and ability to defeat surface-to-air systems, allowing them to devote more attention to weapons employment and mission accomplishment. Further, the JSF must be designed with signature reductions in the infrared, near infrared, and radio frequency portions of the electromagnetic spectrum.

IR signature reduction efforts should be concentrated on confusing and defeating seekers of incoming missiles, rather than defeating enemy search and tracking systems. Turbine-powered aircraft are subject to long-range detection and tracking due to the IR signature generated by their engines and by skin friction when operating at high subsonic or transonic speeds.[7] Attempting to make these aircraft "invisible" to sensitive search and tracking systems is a difficult task. IR threat survivability efforts should, therefore, focus on defeating missile seeker heads.

Future IR missile seekers will use all portions of the IR spectrum. Defense industry analysts hypothesize that the ultraviolet (UV) portion of the electromagnetic spectrum will also be used to target aircraft. JSF development should determine the feasibility of signature reduction in each of these spectral areas and incorporate appropriate countermeasures. For example, IR emissions could be reduced by insulating and baffling engine and exhaust areas. Likewise, shielding the JSF's UV emissions could reduce the effectiveness of a tracking system.

RF signature reduction should also be incorporated into the design of the JSF, but not to the point of providing a stealth aircraft. The desire for "stealth" should not override JSF strike warfare mission requirements. The JSF will be required to perform as the preeminent strike fighter in the world's littoral regions. This is an environment which demands an aircraft capable of flexible weapons loads. It also demands an aircraft capable of supporting troops in contact with enemy forces on the battlefield. These requirements necessitate external weapons carriage which is not congruent with stealth technology.

Complete internal carriage of weapons is required to achieve RF "stealth" standards.[8] External pylons and their suspended ordnance present reflective surfaces which significantly increase an aircraft's radar cross section (RCS) and enemy detection range. According to the radar detection range equation in *Introduction to Airborne Radar,* very significant and expensive decreases in RCS must be made to achieve stealth.[9]

For example, to decrease radar detection range by fifty percent, the RCS of an aircraft must be reduced to 1/16th of its original size. This reduction in RCS can also be expressed as -12 decibel square meters (dbsm). To reduce target detection range from 80 nautical miles (NM) to 10 NM, the RCS would have to be reduced to *1/4000th* of the original, or -36 dbsm. In other words, a nominal 10 square meter target normally detectable at 80 NM, would have to be reduced to .0025 square meters RCS to reduce maximum detection range to 10 NM. While this capability is tactically significant, it requires a design which prohibits external weapons carriage.[10]

Stealth is not required in accordance with the proposed threat, nor is it congruent with the JSF mission. Consequently, the preponderance of signature reduction efforts

should be concentrated in the IR spectrum, with RCS reduction technologies applied only when they do not interfere with JSF mission requirements.

Threat Warning and Countermeasures

Strike-fighter aviators use a variety of tactics and systems to protect themselves from surface-to-air threats. The most effective tactic is to avoid the threat system's lethal range. Unfortunately, this option is not always possible, especially in an environment where shoulder-launched IR SAMs are prevalent. In these situations, the aviator depends on a combination of missile warning, visual acquisition, aircraft maneuver, and dispensable countermeasures to defeat a launched SAM. These techniques are effective and inexpensive. The JSF should continue to expand capabilities in these areas with state-of-the-art warning and countermeasures systems.

JSF cockpit warning of IR and RF threats should provide precise identification and location of the threat. Present radar warning receivers are limited to only an approximate determination of azimuth. Infrared warning receivers are not presently fielded in fighter-attack aircraft. This shortfall is partially responsible for US losses to IR SAMs during recent conflicts. The JSF must improve RF warning and fill the void in IR detection systems.

The JSF warning system should be sensitive enough to detect and identify all future threats. The system must aurally and visually alert the pilot to the threat's exact identification and location. The threat's altitude, azimuth, and range should be clearly displayed in the cockpit. The aviator could then visually acquire the threat, begin defensive maneuvering, and dispense appropriate countermeasures to defeat the attack.

This detection system should further allow aircrews to precisely target a threat's location if they decide to retaliate. This advanced system is necessary to ensure aircraft survivability in future warfare.

Passive countermeasures are an integral part of the survivability equation. The JSF should combine the reliability of past countermeasures systems with emerging technologies. Simple, reliable systems must be augmented by advanced systems that target IR seekers, such as blinding lasers.[11] Three notes of caution are necessary. First, it is essential that traditional expendables, such as chaff and flares, are augmented by technologically advanced systems, not replaced by them. Second, many strike fighters, such as the F-16 and F/A-18, carry an insufficient number of dispensable countermeasures. The A-10, which relies heavily on countermeasures for self-protection, carries nearly 500 expendables. The JSF should carry a similar number of decoys. Finally, the dispensable countermeasures system needs to be simple. The controls should be easily accessible and manageable in flight. Systems that rely on ground maintenance crews for programming are problematic. The JSF design must address these three issues.

Active IR countermeasures for the JSF will also be critical. The most effective method to deal with IR missile threats is to interfere with seeker tracking. This could be accomplished by using an IR seeker jammer that disrupts or destroys the missile's optical seeker. The power required to disrupt or destroy the imaging seeker of an IR air-to-air missile or SAM is low due to their high gain. Lasers, with power outputs equivalent to those systems currently installed in the F-16, could effectively blind incoming missiles.[12]

The promising capability in the IR spectrum is tempered by pessimism in the RF spectrum. The poor track record of the US defense industry in the development and

production of active radar missile countermeasures (radar jamming) leads this study to view these systems with skepticism. The ineffective internal countermeasures suites of the B-1 and the F/A-18 are indictments of these systems. They do not consistently create miss distances outside the lethal range of threat warheads. The development of RF systems for the JSF must correct this shortfall by providing effective and reliable active countermeasures.

A Foundation for Performance

The JSF needs to be an all-weather, day/night, strike fighter. Lessons learned from Vietnam and Desert Storm illustrate that such aircraft, equipped with internal target designators, are highly desirable assets. Studies of the effectiveness of close air support (CAS) during the Vietnam War indicated that "there was a strong correlation between enemy ground gains, high enemy activity, and bad flying weather. In general, the enemy took advantage of bad weather to attack and effect his major gains."[13] This tactic will be encountered on future battlefields against insurgent or guerrilla forces. The JSF should be designed to counter it.

The ability to fly and fight at night or in bad weather offers the combatant commander a significant tactical advantage. Night air operations enhance survivability and complement night ground operations. IR SAMs that normally rely on visual acquisition are less capable and threatening. Night air-to-ground missions, like all-weather missions, are difficult in terms of navigation, target detection, and identification. To be effective in this regime, the JSF will need an integrated all-weather detection and

navigation capability that enables it to perform the mission of strike warfare. This capability exists in a limited number of US aircraft, leaving the JSF to fill the void.

The JSF should be designed around an integrated navigation, radar, and sensor system. This would ensure autonomous aircraft performance. The projected reliability of Global Positioning System (GPS) receivers should be questioned. The JSF should incorporate GPS technology, but it should also maintain a separate navigation capability. The integration of a ring-laser gyro inertial navigation system would meet this requirement and provide a desired redundancy.

The emerging ability to fuse sensor data from another aircraft or platform with data generated onboard is beneficial and desirable. However, total reliance on off-board sensors would be shortsighted and would degrade independent capabilities. It would be naive to assume constant and continual access to all national and theater-level reconnaissance and surveillance assets. This study submits that off-board sensors should be viewed as complementary inputs to the JSF avionics suite. They should be used to improve navigation and overall situational awareness, not as a substitute for organic capability.

Future missions will require the JSF to be self-sufficient in detecting, identifying, tracking, killing, and assessing the damage to enemy targets. The JSF should be developed with the capability for independent operations in all five of these areas. This desired capability should be known as the "JSF Attack Cycle" (fig. 7). Each of these areas will be examined in greater detail.

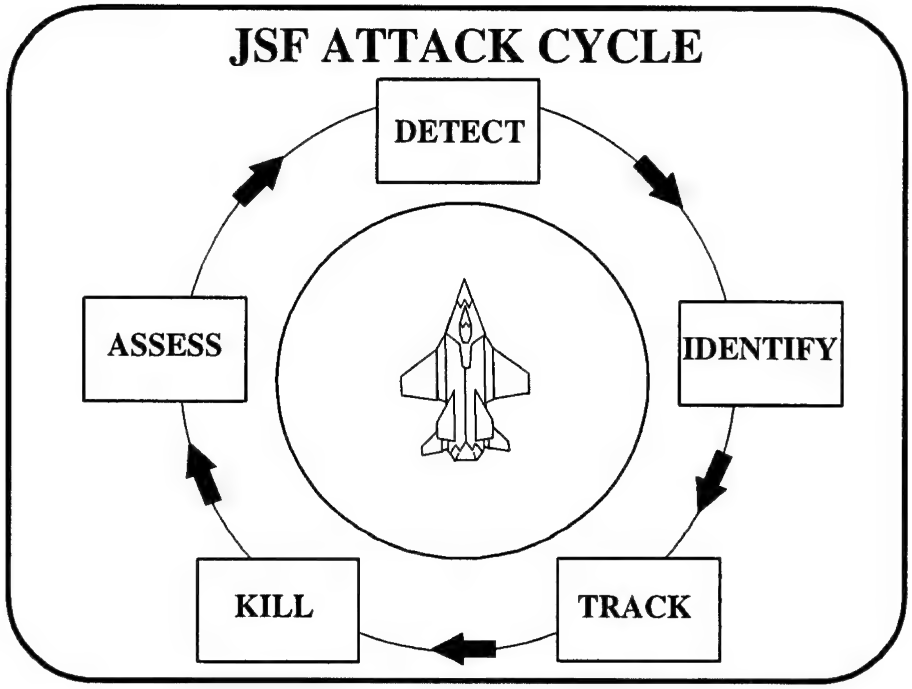


Figure 7. JSF Attack Cycle

Target Detection

Target detection is the most difficult task a strike-fighter pilot must perform. A combination of extremely accurate navigation, radar, and sensor equipment will enable the JSF to perform this task better than any rival on the future battlefield. The strike-fighter mission will require the JSF to fight its way to the target, kill it, then fight its way back to the intended point of landing. To accomplish these tasks, the JSF must be able to detect an airborne adversary at a minimum distance of 70 NM, based on the postulated capabilities of future air-to-air missiles. This range will allow pilots to properly analyze adversary formations, identify targets, determine an attack plan, and execute the intercept. This must be accomplished while outside the adversary's lethal launch envelope. Any

decrease in detection range capability will handicap the survivability of the JSF in air-to-air threat environments.

An active, electronic scanned-array (ESA) antenna should be included in the JSF radar system. This type of antenna would provide unmatched tactical capability with tremendous growth potential. An ESA antenna would allow the JSF to remain superior to all threats throughout its expected life.[14] It would facilitate the development of passive and active sensors across the entire RF spectrum. To take advantage of this technological advance, the system software and hardware requirements must be integrated into aircraft design from the beginning. The cost of retrofitting an ESA into an existing platform or radar would be prohibitive.[15]

ESA technology would allow the JSF to make a quantum leap in strike warfare. An ESA-equipped JSF could perform simultaneous air-to-ground and air-to-air detection operations. This highly capable system would present the JSF pilot with separate pictures on separate displays (fig. 8). The air situation display would allow the pilot to monitor the air picture and defend against any threats en route to the target. At the same time, the battlefield situation display would allow the pilot to detect and attack stationary or moving ground targets.[16] The ESA would also permit the pilot to reduce the emissions signature of the aircraft through the use of low probability-of-intercept techniques. The ability to minimize radar reflectivity greatly increases aircraft survivability.[17]

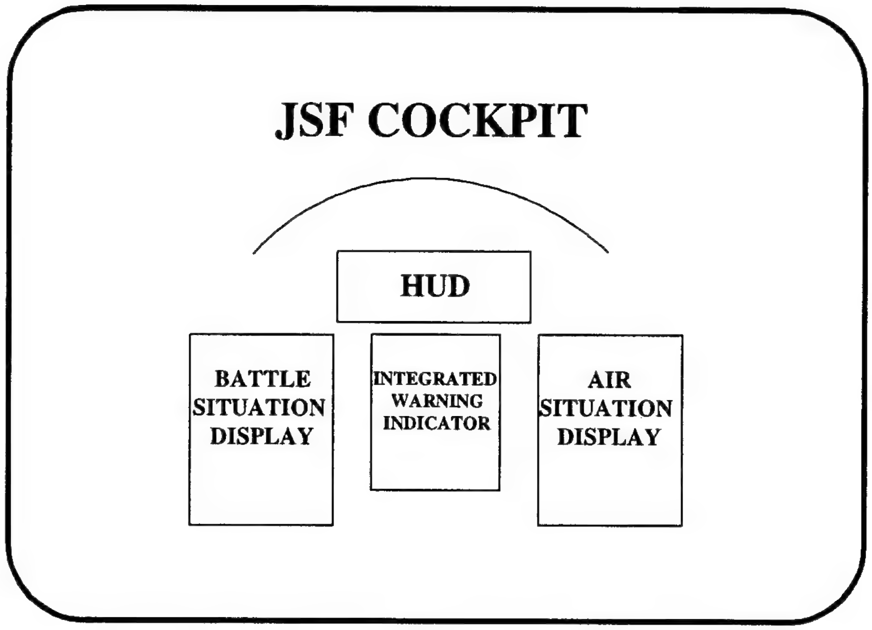


Figure 8. JSF Cockpit Displays

Identification of Targets

It is critical that a system capable of positive target identification be included in the avionics suite of the JSF. According to a World War II field manual, "the first requirement in warfare is the ability to distinguish friend from foe."[18] This requirement is still paramount today and will exist on the battlefields of tomorrow.

Current strike fighters are inadequate in this capability. According to data gathered at the National Training Center, target misidentification, poor navigation, and coordination errors have accounted for 71% of all direct fire fratricides since WWII.[19] During combat operations in Desert Storm, 107 US servicemen were killed or wounded in action as a result of friendly fire (fig. 9).[20] Air-to-ground fratricide accounted for 26 of these casualties.[21]

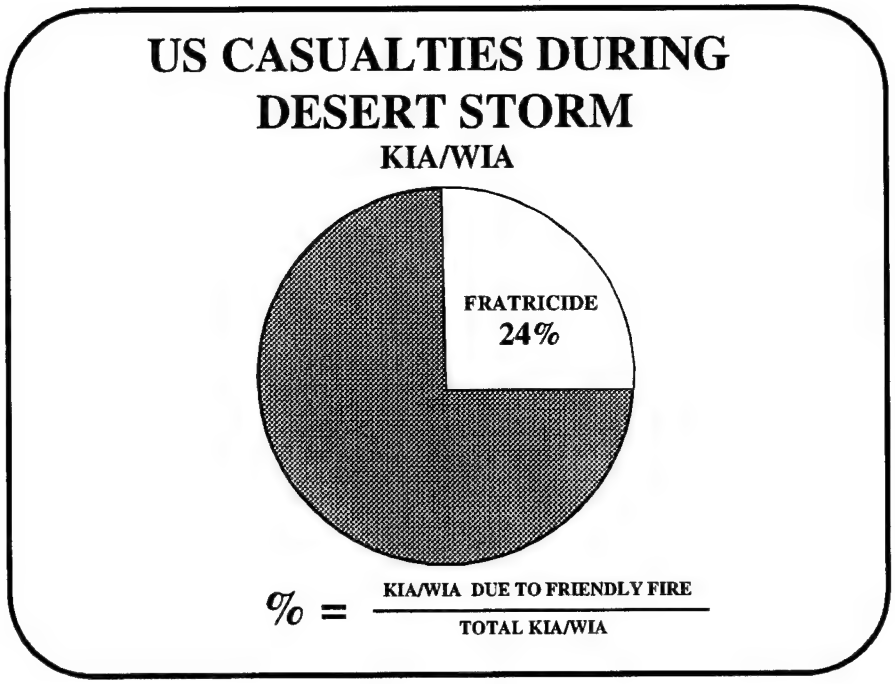


Figure 9. Desert Storm Casualties

The employment ranges and lethality of future weapons will continue to increase. To ensure the safe employment of these advanced weapons, the JSF should provide the pilot with identification systems that allow for an accurate decision to engage a target. This awareness should be derived through redundant, yet independent, identification systems internal to the aircraft. The JSF should not have to rely on remote sensors in supporting aircraft for engagement information. The downing of two US Army helicopters by USAF F-15s in 1994 is harsh evidence of this shortfall.

The JSF identification system should be integrated with its navigation, radar, and sensor systems to provide the pilot with accurate air and ground awareness. Positive hostile and positive friendly identification systems should allow rapid identification and location of friendly and hostile forces. This would decrease friendly-fire incidents and expedite weapons employment, enhancing mission accomplishment.

Target Tracking and Designation

Once the JSF is maneuvered within range of enemy targets, it will depend on sensors to track and designate targets for destruction. JSF onboard sensors must be integrated with the navigation, radar, and weapon systems to ensure accurate weapons delivery. The JSF pilot should be able to designate ground targets using a variety of means. The ESA radar, the navigation system, an onboard sensor (such as a forward-looking infrared pod), or a designating device (such as a laser designator or a helmet-mounted sight) should allow precise weapons delivery. These systems should be redundant. If one sensor is unable to provide all the necessary information to track and designate a target, the other sensors should fill the void.

Desert Storm operations placed a premium on aircraft with a self-contained laser-designation capability. These aircraft were extremely valuable to the combatant commander. Nearly every US military aircraft with a laser designation capability went to the theater and more were needed.[22] A laser designation system should be integral to the JSF sensor suite. A self-designation capability will reduce force requirements and enhance overall survivability by limiting the number of aircraft required in target areas.

To further enhance target tracking and designation, the JSF should incorporate an integrated helmet-mounted sight (HMS) system. The ability to slave sensors and missile seekers to the pilot's line of sight will be critical to success in future air-to-ground and air-to-air engagements.[23] Aviators should be able to designate ground targets, input coordinates directly into the fire control system, and launch weapons without having to point the nose of the aircraft at the target. This off-boresight, air-to-ground capability would particularly enhance ordnance delivery in a high-threat, all-weather environment.

Killing the Target

The expeditionary nature of future warfare indicates the need for a quick-response strike fighter, able to accurately deliver a variety of weapons. Multiple weapon loads and rapid ordnance reloading at expeditionary bases can only be accomplished using external weapons stations. The JSF development team should concentrate on maximizing the firepower of external weapons carriage.

This externally carried ordnance should not be limited to a small number of precision-guided munitions. Granted, the laser-guided bombs dropped by many coalition aircraft during Desert Storm proved devastating to targets with single nodes of vulnerability. However, these weapons were much less effective against area targets due to insufficient quantity.[24] Widely dispersed targets will continue to be present on future battlefields and the JSF must carry enough ordnance to destroy them.

The JSF should be designed to deliver all joint, conventional, and precision-guided munitions in the inventory. Air-to-ground ordnance must be delivered with "first-pass-kill" accuracy. The capabilities of the new class of joint munitions (the Joint Direct Attack Munition and the Joint Stand-Off Weapon), combined with the JSF's target detection, identification, and tracking systems, will be unmatched in accuracy and lethality.

A capable gun will enhance the CAS and the anti-air warfare (AAW) missions of the JSF. This gun should possess sufficient caliber and muzzle velocity to damage heavy tanks with enhanced armor protection. A high kinetic energy projectile would also increase the gun's effectiveness in the air-to-air role, due to its striking power and

effective range. To ensure the gun's accuracy, an all-aspect, predictive gun sight with air-to-air and air-to-ground capability should be integrated into the JSF avionics suite.

Many current strike fighters carry the equivalent of one 3-to-5 second burst of gun ammunition. This limits the number of targets that may be engaged. At one pound of weight per 25 mm gun round, 1000 rounds are equivalent to the weight of one 1000 pound bomb. The bomb can be used to engage only one surface target, but the gun can engage multiple surface and air targets using the same ordnance weight. Further, an internal gun does not occupy a wing weapons station. The JSF should carry an internal gun with a minimum of 1000 rounds.

The JSF needs to be able to fight its way to the target, drop its ordnance, and fight its way home. It does not need to be a premier air superiority fighter, but it should possess a credible, medium-range, air-to-air missile capability. This would allow the JSF to gain localized air superiority in the absence of other US fighters or when circumstances prohibit the deployment of larger air forces. For this purpose, the JSF should be capable of carrying a minimum of two medium-range, radar-guided missiles (such as the AMRAAM) and two short-range, IR guided missiles (such as the AIM-9X), in addition to its strike ordnance load. For those occasions when the combatant commander needs to employ the JSF in a strict AAW role, it should be capable of carrying a minimum of four medium-range, radar-guided missiles, in addition to its short-range missiles. The JSF's short-range missiles should be slaved by the HMS to enable expedient, visual targeting of opposing fighter aircraft.[25]

Assessment

Battle Damage Assessment (BDA) is a measure of success for strike missions. Planning staffs must know if targets have been destroyed in order to determine if follow-on attacks are needed. Planners can obtain BDA through the use of aircraft with various sensor systems. The JSF, with its inherent capability to detect, identify, track, and kill a target, will automatically be able to provide BDA to air and ground commanders.

The same sensors that provide the battlefield picture to the pilot, could be used to data-link images to an air operations center or command-and-control aircraft. Data-link of actual sensor views of the target before, during, and after engagement will enable real-time decisions to be made. Additionally, the JSF should possess a video tape recorder capable of recording images the pilot deems necessary for intelligence purposes. This would ensure the accuracy of pilot reports in future conflicts.

Summary

This development study strongly suggests that the current JSF design requirements be reconsidered. The JSF should be designed with the IR threat driving survivability efforts, not the RF threat and its exacting requirement for stealth. Additionally, this study proposes that the JSF should be designed with an integrated navigation, radar, and sensors package capable of ensuring independent operations. The JSF should not be dependent on external sources of information, rather it should use them to complement aircraft capabilities. The aircraft should be designed as the premier all-weather, day/night, strike fighter capable of successfully executing the JSF attack cycle.

Notes

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[20] Ibid., 23.

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[23] Dornheim, 36–39.

[24] Keaney and Cohen, 227.

[25] Dornheim, 36–37.

Chapter 4

The Benefits of a Single Joint Airframe

We train as a team, fight as a team, and win as a team.

—General Colin Powell (CJCS)

Introduction

Chapters 2 and 3 have demonstrated the direction the United States Armed Forces are headed, their future joint roles and missions, the type of organic air support they will require, and the advanced technology aircraft needed to guarantee success in the 21st century. This chapter will focus on the benefits and cost savings realized from the production and operation of the JSF through the elimination of redundancies and by increasing efficiencies in aircraft operations, training, and maintenance.

Operational Benefits

The research team identified two major areas where the JSF could have a significant impact on operations. These two areas are the physical size and nature of runways, and the cross-utilization of all three services' facilities.

First, it could operate from runways that are shorter and narrower than those used by present day strike-fighter aircraft because of its STOVL capability. Likewise, the JSF could operate from forward locations that are not fully prepared. These are not new

concepts. The Navy and Marine Corps have been operating from expeditionary airfields (EAFs) in these environments for a number of years. US forces will continue to do so in the future. The Navy and Marine Corps have made Expeditionary Airfield 2000 (a temporary airfield quickly installed by ground forces) a top procurement priority for the 21st century. The JSF would be suited to operate from these "portable" airfields, as well as from traditional airfields and aircraft carriers. The end result is that the JSF would provide increased capability and flexibility for both the USAF and the USN.

With a history of conducting flight operations from fixed sites, the USAF would benefit significantly from STOVL flight and a reduced airfield footprint. For example, an enemy attack that craters a runway would no longer automatically close the field until repairs are made. STOVL departures and recoveries could simply shift to a remaining section of the runway or adjacent taxiway. The US Navy would be less dependent on tail-hook equipped aircraft and the equipment needed to launch and recover them. The flexibility they already enjoy while conducting Harrier and helicopter operations would be extended to another airframe. These advantages of the JSF lead directly to the second major area of operational benefits.

With the proper amount of joint training, pilots from the Air Force, Navy, and Marine Corps could all operate from ships as well as airfields. Under this concept, Air Force pilots would operate off carriers, Marine Corps pilots would operate out of air bases, and Naval aviators would fly in and out of littoral strips just as easily as they operate from their own facilities. Additionally, the ability of CONUS-based air assets to deploy overseas expeditiously would be aided by the employment of the STOVL JSF. Each service would be able to "carrier-hop" JSF assets into a combat area when tanker

assets are limited. They could then stage their forces from an amphibious platform, an expeditionary site, or an airfield (fig. 10).

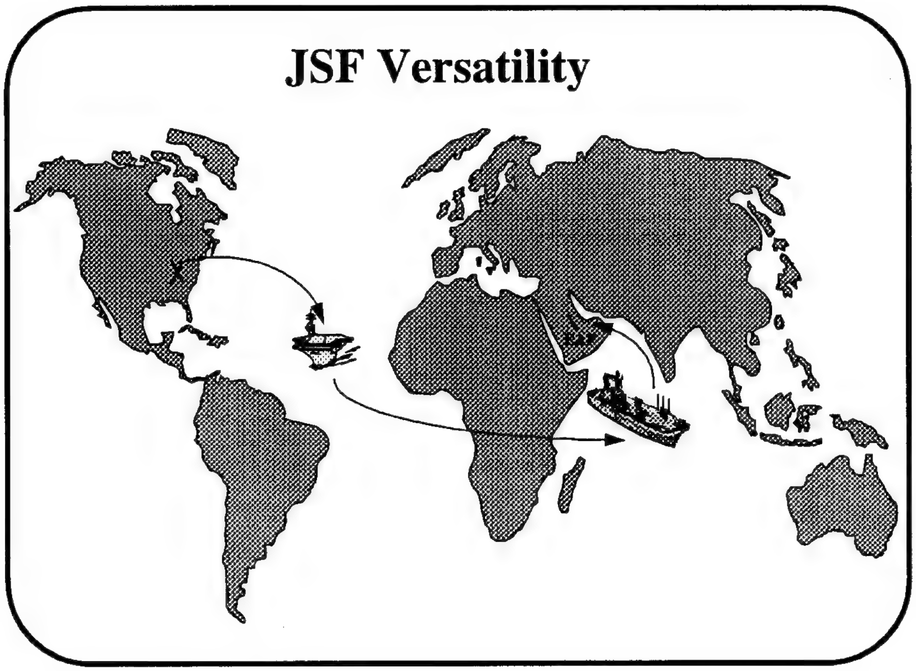

Figure 10. JSF Versatility

The versatility derived from such cross-deployment of forces could be critical to an operation's success in the combat arenas of the future, especially if basing rights are limited. Recent years have witnessed a significant reduction in US overseas bases. Some of these instances have been voluntary closures, while others have been at the request of the sovereign nation. These reductions could lead to scenarios where the US does not have a land base within range of a given Area of Responsibility (AOR), leaving its forces with two options. The services could take a sector of land by force and set up an operating strip, or they could operate from ships. The Navy and Marine Corps already do this. With the addition of the JSF to its inventory, the Air Force could provide added firepower in the critical early stages of a conflict. Alternatively, the attrition of Navy or

Marine Corps pilots early in a campaign could be compensated for by highly trained replacements from the Air Force arriving with follow-on echelons.

Training Benefits

The most efficient method of training JSF pilots will be in joint squadrons. All aviators should receive the same level of detailed instruction and flight experience regardless of service affiliation. Such a program would streamline the training process and expose all aviators to the operations and techniques of the other services. This would increase interoperability, familiarization, and tri-service cooperation.

The air forces of all three services are already experiencing joint training. Student aviators are sent to flight training programs run by sister services. Air Force under-graduate pilots are training in Navy helicopter and fixed-wing squadrons. Similarly, naval aviators are being trained in Air Force units in Texas. "Today, as we seriously embrace joint operations in war fighting, the Navy training command is not only following suit, but leading the way in many respects."[1]

The training of student aviators in a joint environment was initiated in anticipation of future developments. In the 1997–98 time frame, all Air Force, Navy, and Marine Corps aviators will begin receiving primary flight instruction in the Joint Primary Aircraft Training System (JPATS). This modern, efficient system of aircrew training will consist of computer-assisted instruction tools, electronic classrooms, modern flight simulators, and new aircraft. The training commands of the various services are providing the framework for this system long before its introduction. Likewise, the services need to develop a framework for the training of tactical strike-fighter pilots. By providing the

structure and organization to commence joint training prior to the introduction of the JSF, the services will go a long way toward ensuring its success.

This will be a marked change from the past when each service was hesitant to have its aviators trained in tactics and flight operations by a sister service. Reduced budgets, limited resources, and congressional demand for military efficiency will require all three air arms to drastically alter their views of joint, tactical training. "As the Armed Forces grapple with change, the emphasis has been on improving management and efficiency. Change also offers opportunities to train as a team. Many are working to expand and consolidate interservice training, including members of Congress, the Office of the Secretary of Defense, and the services, in the face of independent training overheads."[2]

The joint training program should be a continuation of the framework provided by those who train student aviators during the primary phase (fig. 11).[3] Those selected

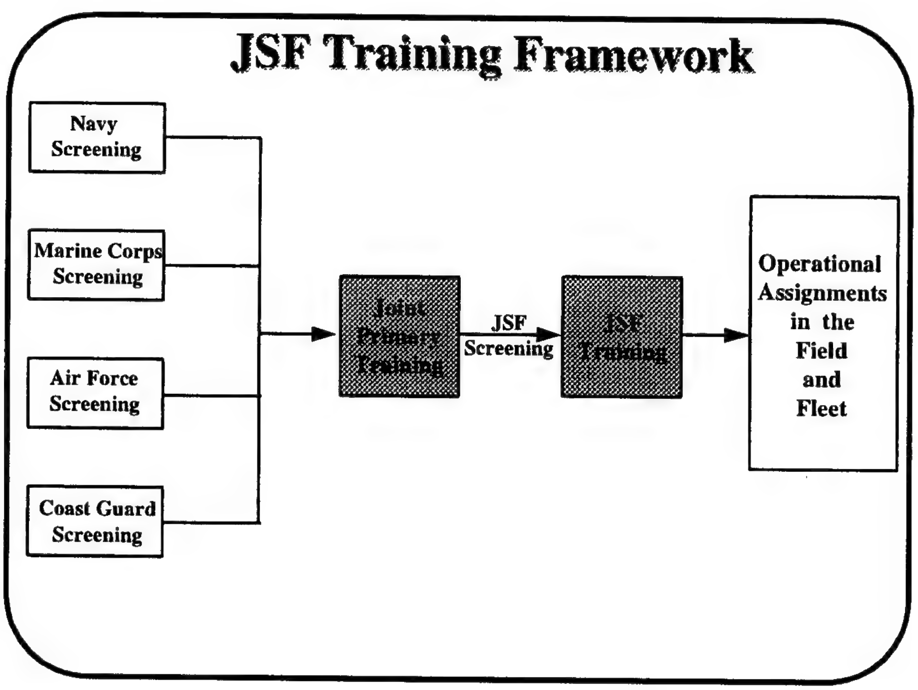

Figure 11. JSF Training Network

to fly the JSF should move immediately to a joint Navy–Air Force squadron and start initial skills training. Instrument, formation, air-to-air, and air-to-ground skills should be taught by instructors from all three services to students from all three services. They must teach standardized joint tactics, techniques, and procedures. "The advantages of interservice initial skills training include lowering costs as redundancies are reduced, downsizing the overall infrastructure, fostering teamwork, and nurturing jointness by exposing students to interservice dialogue early in their careers."[4]

The JSF training program must go beyond initial skills training. Students flying the JSF should be trained to fly from Air Force airfields, Navy aircraft carriers, and Marine Corps expeditionary environments. They should be well versed in all three services' doctrine as well as joint doctrine. The advanced warfighting schools of aerial warfare (USAF Fighter Weapons School, USN Fighter Weapons School, and USMC Marine Aviation Weapons and Tactics Squadron 1) should collaborate to provide tactics manuals that synthesize terminology, provide guidance in the performance of fighter-attack missions, and eliminate redundancies in the tactical arena. "By indoctrinating a good number of aviators into the joint environment early, we will help build a better appreciation for how each service operates."[5] Combat effectiveness would increase since the pilots who fly the JSF would speak a common language, making it possible to fly together in complex air-to-air and air-to-ground scenarios.

Maintenance Benefits

Significant benefits in the maintenance field will be realized with the development and operation of the JSF. The advanced technology used to build the JSF will allow the

services to minimize maintenance requirements, reduce infrastructure, and lower manning levels due to the development of more reliable, repairable, and automated systems.[6]

Currently, the most sophisticated aircraft and weapon systems are avionics intensive and maintained with a 3-level maintenance philosophy. Organizational (squadron level) maintenance entails aircraft servicing, minor repair of structures, and the removal and replacement of defective components. Intermediate level maintenance troubleshoots defective structural, electro-mechanical, or avionics components using extensive layers of personnel and support equipment. Repairs or modifications beyond the organizational or intermediate level are performed by depot level maintenance. This is done by a field team on location or at the depot.

Technological advances in such areas as micro-circuit repair and aircraft diagnostics will permit a transfer of more maintenance responsibility to the organizational or squadron level. Therefore, the JSF will promote aircraft maintenance that is more responsive, capable, and efficient. Such efficiency will lead directly to needed cost savings.

The JSF will be expected to perform in austere and expeditionary sites around the globe. A maintenance system which supports such operations must be implemented. This system must begin with the design of the aircraft. The JSF must be designed with state-of-the-art internal fault detection, isolation, and on-aircraft repair capability. The actual aircraft should be the test bench for diagnostic evaluation and on-site repair. Detailed self-diagnosis systems should allow technicians to rapidly identify defective components and aid in subsequent repair. Micro-circuit maintenance allows the technician in the squadron to repair or replace a damaged component. This would result

in a significant reduction of intermediate-level maintenance needs. Further, it would reduce the need to maintain costly spare part inventories and expensive test equipment.

Maintenance organizations will also need to be tailored and trained for independent operations from highly diverse locations. Operations from amphibious ships and austere sites should be administered by maintenance detachments composed of five to six technicians per aircraft. These small units could be widely dispersed throughout an AOR and frequently shifted to new locations. They would be available for on-site repair at the many distinct locations the JSF will operate from and difficult for enemy forces to track and target. This could greatly reduce their vulnerability to both conventional attacks and weapons of mass destruction.[7]

To maintain aircraft in this manner, deployed JSF technicians will require a superior level of expertise in nearly every facet of maintenance. This elite force must be highly skilled, motivated, and dedicated. To train these technicians, developers of the JSF program will need to evaluate and overhaul current training programs particularly in avionics and computer skills. Maintenance personnel must be trained to perform in the battlefield environment of the 21st century.

Finally, aviation maintenance training should be consolidated to make better use of existing expertise. Maintenance personnel from all three services should train at the same locations where joint flying training squadrons teach JSF pilots. This would save money by reducing infrastructure and introduce an era of joint maintenance.

Summary

The recurrent themes throughout this chapter have been the elimination of redundancy and the promotion of flexibility. The elimination of redundant operations, training, and maintenance programs, made possible by increases in technology and flexibility, is vital to the armed services if they are to maintain present day effectiveness. The savings made possible by the acquisition and operation of a single version JSF are significant. These savings can start with the production of 2816 STOVL JSFs in lieu of 642 for the USMC, 1874 USAF variants, and 300 Naval variants.[8] This would allow the elimination of entire programs for the production of airfield/shipboard tailhooks, airfield/shipboard landing gear, stealth enhancements, and high lift devices.[9] The savings would then continue as all three services operate and maintain this solitary airframe, replacing redundant service programs with solitary joint programs. Joint flexibility and interoperability would be the hallmark of the JSF program.

The Joint Strike Fighter proposed by this developmental study is essential to the future US armed forces and affordable for the American public. This project should be a joint undertaking by all three services utilizing the JAST/JSF concept to produce an aircraft that truly embraces the concept of "jointness by design, not accident."[10] A solitary version of this aircraft would allow for joint acquisition, training, maintenance, and operations. Joint doctrine calls for an aircraft possessing its capabilities. Fiscal constraints demand no less.

Notes

[1] RADM Brent M. Bennitt, "Making Joint Fleet Aviators," *Naval Aviation News* 76, no. 6 (September–October 1994): 1.

Notes

[2] Gen Henry Viccellio, Jr., "The Joint Challenge to Interservice Training," *Joint Force Quarterly*, no. 7 (Spring 1995): 43.

[3] Figure 11 has been adapted and modified from its original form which appeared in: Gen Henry Viccellio, Jr., "The Joint Challenge to Interservice Training," *Joint Force Quarterly*, no. 7 (Spring 1995): 47.

[4] Ibid., 45.

[5] Bennitt, 1.

[6] James L. George, *The U.S. Navy: The View from the Mid 1980's* (Boulder, Colo.: Westview Press, 1985), 155.

[7] Jon T. Hoffman, "The Future is Now," *US Naval Institute Proceedings* 121, no. 113 (November 1995): 31.

[8] RADM Craig E. Steidle, "Joint Advanced Strike Technology Program," *JAST Internet Homepage*, November 1995, Slide 22.

[9] Ibid., Slide 21.

[10] Michael C. Vitale, "Jointness by Design, NOT ACCIDENT," *Joint Force Quarterly*, no. 9 (Autumn 1995): 25.

Chapter 5

An Architecture for Change

The fundamental question is not what is best for the Marine Corps, the Army, the Navy, or the Air Force . . . the question is, 'What is best for America?'

—Senator Sam Nunn
U.S. Senate Floor, 1992

Introduction

The creation of the infrastructure, squadrons, and training syllabi to integrate the JSF into our nation's air forces will require detailed planning. In the next 15 years, the services will require a road map that drives this development study's proposals to completion. This chapter begins by outlining an architecture to ensure the successful integration of the JSF into the nation's air arms. This architecture consists of three distinct and consecutive phases of integration. Each of these phases is dependent on its predecessor to achieve success and will be addressed individually. This chapter will then close with a brief recap of the development study's major conclusions and its bottom line.

Phase I: Planning (1996–2000)

The remainder of this century should be devoted to consolidating the services' strike doctrine and establishing a common foundation for all forces. In aircrew training, maintenance training, and the development of strike tactics, the Air Force, Navy, and

Marine Corps should strive for unity. They should continue to update the eventual design of the aircraft to meet the mission of strike warfare in the year 2010. The critical product of this stage will be a transition plan that fosters interservice teamwork and provides the JSF program with a road map for the next ten years. This campaign plan should be sufficient in detail to provide direction and milestones to the services, while maintaining a degree of flexibility to respond to change. The plan should have an annual review cycle and should be administered by the JSF program office.

Phase II: Transition (2000–2010)

A joint training command should emerge from the roots of the Joint Primary Aircraft Training System (JPATS). The staff, doctrine, and facilities to implement the JSF should be put into place. The JSF campaign plan should be completed and the services should coordinate all aspects of the program. DOD funding should be provided for JSF production. The cost savings due to single aircraft manufacture should be funneled into updated aircrew, maintenance, and tactics training courses. The services should nominate particular squadrons, officers, and enlisted personnel to stand up the training units in the 2008 time frame. The infrastructure previously in place at these locations should be modernized and the units should be prepared to commence training in the year 2010. Transition to a new system of training will be difficult, but previous experience from JPATS implementation and a cooperative effort from all the services should lead to success. The critical event of this stage will be the development of coherent training syllabi for pilots and technicians.

Phase III: Implementation (2010–2015)

The joint training programs for aircrew and maintenance technicians should be in place when the first JSF aircraft arrive at the squadrons. Student pilots should receive a comprehensive curriculum which addresses each service's particular operating environment and distinct requirements. The students should also receive the initial stages of tactical flight training provided from a joint perspective. All students should qualify in specific sorties involving US Navy aircraft carriers and amphibious shipping, US Marine expeditionary sites, and US Air Force airfields. The technicians trained in the transition phase will become the backbone of aircraft maintenance, entrusted with training the next generation of aircrew technicians. JSF implementation will be a slow and arduous process. However, by the year 2015, joint tactical strike warfare should be an operational reality.

Conclusions

This development study is based on the premise that future global and fiscal environments will demand a single, versatile aircraft capable of unmatched strike warfare performance. This aircraft should be the STOVL JSF, designed to perform in the environment described in Chapter 2, to incorporate the features outlined in Chapter 3, and to realize the benefits articulated in Chapter 4 of this study.

The JSF *must* be optimized to perform joint warfare in the expeditionary and littoral battlefields of the 21st century. It must be a preeminent strike fighter, designed to independently perform *the mission of strike warfare* with sufficient amounts of externally

carried munitions. It must be capable of surviving the predominant IR threats of the future as well as the lesser proliferated RF threats.

The JSF *should not* be designed to perform the deep strike mission. It does not need to meet stealth criteria which limits the aircraft to an insufficient number of internally carried munitions. It should not be one of a family of three variants, rather it should capitalize on the operational, training, and maintenance benefits inherent in a single airframe program.

The Bottom Line

The most significant point derived from this study is the emphasis on a new asset and a new perspective for joint warfare. The Air Force, Navy, and Marine Corps must realize that mission accomplishment in the 21st century should never be upstaged by service interests. The aviators that fly and the technicians that maintain the JSF must revere their service identity, yet recognize the advantages of joint operations. Service parochialism must be de-emphasized to the point where the most important "allegiance is to the strength and power of the synergism."[1] The military services have a choice. They can voluntarily fly and fight as a team, or they can wait until Congress and the people of the United States force them to accept this mandate.

Notes

[1] Lt Col Frederick R. Strain, "The New Joint Warfare," *Joint Force Quarterly*, no. 2 (Autumn 1993): 23.

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